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The ILLUMINATING ENGINEER

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Edited by

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Principal Contents:

Why No Statutory Requirement of Adequate Lighting in Factories?

GOOD Lighting in the Factory is now an Admitted Necessity, in the interests of management and workers alike.

It is now 25 years since Silvanus Thompson, in his inaugural address to the Illuminating Engineering Society, pointed to the example of Holland, which had already framed legislation on industrial lighting.

It is 24 years since a Departmental Committee on Accidents in Factories and Workshops in this country urged that adequate lighting should be included in the British Factory Acts.

It is 20 years since the Departmental Committee on Lighting in Factories and Workshops repeated the recommendation—pointing out that Austria, Hungary, Belgium, Denmark, France, Germany, Holland, Italy, New South Wales, Norway, Sweden, and America all possessed legislation on industrial lighting!

Much valuable educational work has been done by the Home Office Factory Department since then. All intelligent employers and workers now know that action is for their material benefit and would welcome it.

We don't want complicated rules and codes—just a **Simple Statutory Requirement of Adequate Lighting** in general terms which the Factory Department could amplify from time to time.

The recommendation is more than 20 years old.

Isn't It Time that Something was Done?

A Standard of Daylight for Cricket?

The old, old controversy regarding what constitutes a "bad light" in cricket has recently been revived. In a note in the daily Press on this subject it is asked: "Is there no way of measuring light? Cannot some photographic process be used to standardise the thing?" The answer, of course, is in the affirmative. The National Physical Laboratory have for years carried out measurements of daylight, which can now be undertaken continuously and automatically by the aid of the photo-electric cell. It should be possible to fit up an arrangement on the roof of the pavilion at Lord's which would ring a bell when daylight had fallen to a certain value in foot-candles. It would only be necessary for a committee of cricketers first to establish the "grumble-point." It might perhaps be urged that such a measurement does not always indicate when visibility has become too poor for the batsman's comfort, but it ought to do so with fair accuracy, and the method would at least be better than the present one of relying solely on personal impression. In the long run a batsman's ability to see no doubt depends mainly upon contrast between the moving ball and its background. If sighting-boards were always provided at *both* ends of the ground, and if there were available a few projectors so that failing natural illumination on these boards could be supplemented by artificial light, complaints of bad light and interruptions of play owing to this cause would become infrequent.

"Please Cross Here"

The criss-cross white lining recently adopted to indicate safe crossing-places for pedestrians in London has excited much comment. The object of drawing attention to these crossings has at least been achieved. It would seem, however, that the threat of a fine of 5s. to "jay-walkers" (almost all of us fall into this category at times) is not quite happy—seeing that anyone is free to dodge the traffic at other points without pecuniary risk. During the long summer days one thinks naturally of appearance in daylight, but in winter the marking out of such authorised crossings by artificial light seems expedient. We notice a comment in the Press on the very poor appearance of many of the "Please Cross Here" notices, most of them makeshift devices, which are now assuming a decidedly shabby and weatherbeaten appearance. What a contrast exists in Piccadilly Circus between these notices and the handsome specially designed lamp-posts. The utility of these warning notices has surely been proved by now. Permanent notices of good design, well maintained and adequately illuminated by night, ought surely to be substituted.

A Licensing System for Signs

Our recent note on illuminated signs has brought us a belated letter from a correspondent, who remarks that disfigurement is much more serious on the open roads than in cities. This seems to be confirmed by some of the illustrations given by Sir Lawrence Chubb, Secretary of the Scapa Society, in a recent address to the Master Sign Makers Association. The President of the latter body, Mr. A. W. Beuttell, took a wide view of this thorny problem, and mentioned that the Association had recently set up a special amenities committee. It was a happy idea to invite Sir Lawrence Chubb to address the M.S.M.A. In the amicable discussion that ensued, the desirability of some system of licensing was suggested. It does seem ground for complaint when, as was remarked, one cannot travel in any direction out of London without being repeatedly warned that "You have a liver!"—an accusation which floodlighting only serves to stamp home. It is, unluckily, rather late in the day to try to grapple with this problem, but not too late to take measures lest worse befall us.

Good Industrial Lighting No. 5

Courtesy, The E.L.M.A. Lighting Service Bureau

This picture of a drawing office, which appeared in Electric Handbook No. 7B (Factory and Workshop Lighting) issued by the E.L.M.A. Lighting Service Bureau, shows the use of general diffused lighting, of the kind recommended below. This system is in itself helpful in preventing the formation of unduly sharp shadows, but is advisedly supplemented by adjustable local lighting units, which afford the extra illumination that the draughtsman requires and can be so placed that all troublesome shadows from the edges of drawing instruments are completely avoided.

How to Avoid Troublesome Shadows

TO the two main essentials of good lighting, Efficient Illumination and Absence of Glare, may be added a third—the Avoidance of Troublesome Shadows. Let it be noted that it is only troublesome, prejudicial, or possibly dangerous shadows that we wish to avoid—not *all* shadows.

"Shadowless" Lighting Not Wanted.

Claims are not infrequently made for systems of lighting that they are "shadowless"—a mistaken claim. No practical system of lighting can give no shadows at all, nor, if it did do so, would this necessarily be a recommendation. Shadows are frequently an aid to visibility. It is, for example, only by aid of the minute shadows cast by the irregular surfaces of cloth stuffs that we recognise their texture. Trees and foliage casting no shadows would lose most of their charm. The works of a sculptor exhibited under shadowless light would lose all distinctiveness.

The nearest approach to shadowless conditions would perhaps be found at the centre of that useful photometric device, the integrating sphere. In practice such conditions are not found. What those who claim a shadowless system of lighting really mean is that the shadows are soft, with such indefinite edges as to be inconspicuous to the eye. Such conditions are frequently possible in offices and factories, and are often desirable—but not always so.

Avoid Shadows on the Work.

What *is* always important is to avoid shadows, especially dense shadows with hard edges, in places where they are not wanted. Many forms of shadows are obviously troublesome, for example, shadows cast on the work by the head and shoulders of an operator; or on the writing by the hand of the writer; or in a drawer or cupboard into which the light does not fully penetrate.

Dangerous Shadows.

In other cases shadows may be positively dangerous, as, for example, when a deep shadow cast by the edge of a cutting tool or a revolving saw makes the outlines of such dangerous machinery difficult to distinguish; or when, on scaffolding, the dense shadows cast by isolated light sources make it difficult to distinguish a chasm from solid footing.

Equally trying in another way are the shadows cast by moving objects, for example, belting in factories, when coming occasionally between the lamp and the worker, or the continual trembling of the edges of shadows caused by slight vibration of light-sources, as sometimes happens when lamps are insecurely mounted and there is much massive machinery in violent motion.

Importance of Diffused Light.

All such defects may be largely avoided by careful selection of the positions of light-sources, but they are most completely minimised by adopting diffused lighting, such as gives not "shadowless" conditions, but shadows with very soft edges. This diffusion of light may be effected by two main methods, best used in combination—by screening the light-sources by means of suitable diffusing glassware, and (2) by making use of the reflecting power of walls and ceilings, or, if this is impracticable, extending the area of the reflectors used with the sources of light. In both cases the aim is to ensure that the light comes from a fairly luminous surface instead of a point.

A combination of the two methods, for example, the use in offices having light-coloured walls and ceilings of lamps completely screened by opal glassware, should result in shadows so soft as to cause little or no inconvenience—especially if the fittings are of a type that allows a substantial proportion of the light to strike the walls and ceilings and to be reflected therefrom. This condition is met still more perfectly in the case of a semi-indirect system, where the condition of the walls and ceiling and the facilities for regular maintenance favour this method of lighting.

As the light is derived from large luminous surfaces, so it is difficult for any solid object, such as the head or hand, to block the light completely;

the edges of shadows are *soft*—with direct and indirect lighting sometimes so soft as to be almost inappreciable.

"Invisible" Shadows May Mean Loss of Light.

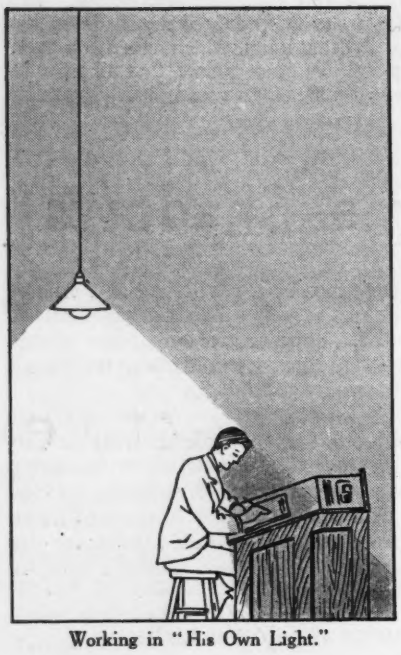
It should not be assumed, however, that because shadows cannot be seen, there are no shadows! The absence of hard edges does much to prevent the shadows proving distracting or dangerous, but the shadows nevertheless are there, and may occasion considerable loss of light.* It is obvious, for example, that in a room lighted entirely by means of an illuminated ceiling, the head and shoulders of a worker bending over the table must block a considerable area of ceiling, and therefore reduce the available illumination on this work. In such cases, no appreciable shadow of the body can be seen. Yet a photometric measurement will demonstrate the loss in light. A curious instance of this effect —the apparent loss in illumination when dark-coloured machinery is introduced into a workroom with light-coloured walls and ceilings—has been recorded. In one such case the manager of the factory, who had witnessed the effect of the lighting system in the empty room, could scarcely believe that the lamps had not been changed when he saw the room again with the machinery in position. The explanation of the loss in light was, however, obvious —the blockage of much of the light hitherto received by reflection from the unobstructed walls and ceiling. The modern practice of painting inactive parts of machinery a light grey so that they, too, become good reflectors of light, has thus much to recommend it.

Notwithstanding the above phenomenon, the diffusion of light in the manner described is almost invariably advantageous, and may be commended for general office and factory practice. Even in cases where it is not wholly satisfactory, the method still commends itself as the basis of general lighting, to be supplemented by special local lighting for exacting tasks.

The Lighting of Drawing Offices.

Indirect and semi-indirect lighting are often recommended for use in drawing offices, and it is true that the good diffusion of light which they ensure has substantial advantages, e.g., in eliminating evident head-shadows and also the casting of sharp shadows by the edges of drawing implements—always a difficulty with general lighting by direct methods. Nevertheless, the writer considers that if any but the simplest form of draughtsmanship is undertaken, supplementary local lighting is expedient. It must not be overlooked that in the case of a draughtsman bending over his work, much of the effective illumination may really be lost owing to a "concealed shadow," i.e., the working illumination is, in fact, often much less than a conventional photometric test in the room would suggest.

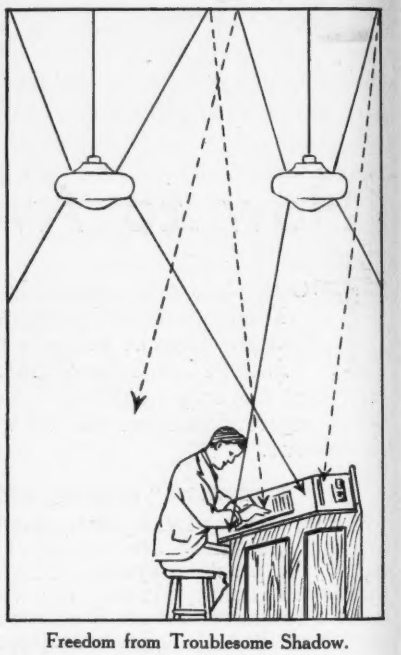
Furthermore, for tracing and other forms of work, an exceptionally high illumination beyond that ordinarily furnished by general lighting may be needed. For this reason, a well-designed system of local lighting, with lamps completely screened from the eyes of the draughtsman, and fully capable of adjustment, so that the rays of light may come at any angle he desires, seems expedient.



Working in "His Own Light."

These two pictures show an extreme contrast. The man on the left is "working in his own light,"—*i.e.*, his head and body come between the source (an electric lamp in shallow opal shade) and the desk. Partial shadow is caused by the opal shade, but the desk is in dense shadow, so that the man cannot see what he is doing.

With the diffused lighting shown in the right hand illustration no troublesome shadow arises. The man would work in partial shadow if he relied only on the fitting behind him, but the fitting somewhat in front and above him sheds direct light on the desk, which also receives scattered light reflected from walls and ceiling, to which *both* units contribute. Moreover both lamps are surrounded by diffusing glassware, so that they cast only soft shadows.



Freedom from Troublesome Shadow.

When Local Lighting is Useful.

Shadow conditions to some extent determine certain cases in which the merits of local lighting were summarised in a previous article in this series. Thus in the case of some forms of fine work, such as knitting and engraving, sharp shadows, revealing surface irregularities, may be helpful, and hence a local source *of small dimensions*, under the full control of the worker, is helpful. In other cases even the most highly diffused system of lighting cannot overcome the blocking effect of masses of machinery, so that special local lighting at points of critical importance may again be requisite.

Finally, it should be remembered that well-designed local lighting is often a potent means of eliminating shadows inherent in the general lighting system, which might otherwise cause trouble. A well-screened local light may be placed quite near the work—sometimes only a few inches away—thus furnishing an illumination so high as to "smooth out" all extraneous shadows. Moreover, as the source of light is placed between the operator and the working material, shadows of the head or body are not likely to arise, and shadows cast by the fingers or tools can be avoided by suitably adjusting the position of the lighting unit.

* See "The Effects of Internal Obstructions on the Performance of a Lighting System," by J. W. T. Walsh, ILLUMINATING ENGINEER, February, 1925, pp. 36-38.

The heather walk, which provides blossoms from Christmas onwards

Looking south from the library

The Art and Practice of Garden Illumination*

By

JUSTUS ECK, M.A., Cantab., M.I.E.E.

* Paper read at the meeting of the Illuminating Engineering Society, held at the Institution of Mechanical Engineers, Storey's Gate, St. James's Park, London, S.W.1, on Tuesday, April 10, 1934.

Courtesy, Good Housekeeping

Introductory.

AS an addition to the amenities of civilised life the festive lighting of outdoor spaces has long been appreciated.

Oil or wax burning wicks in tinted glass receptacles, gas flames or mantles, often in opal or coloured globes, or electric bulbs coated with varied hues have been used for outlining, marking, or emphasising features of parks or recreation grounds or the beflowered surroundings of residences.

The outdoor illuminations seen in many seaside and inland popular resorts form an appreciated part of the local attractions, and are characteristic of the recognition of artificial light, of all kinds, as a valued possession. Owing to its correct application in the present day, by trained specialists, light is taking a firm hold on the public imagination and taste.

The International Illumination Congress, held in this country in 1931, afforded many people throughout England and Scotland, hitherto uninterested in the subject, the opportunity of seeing what a competent study of lighting problems could effect, after nightfall, as an outdoor attraction without any accompaniment of action, noise, or music. The illumination of many familiar buildings filled the streets with satisfied onlookers. Pre-eminent among the many successes was the lighting of the flowers and foliage of St. James's Park, London. This novel and enterprising achievement, created a lasting impression. The charming effect, though exhibited in part in the pictures I am able to show you, like all photographs of gardens, cannot adequately represent the visual impression. Colour and background inevitably fail. Actual viewing is in this branch of illumination almost more important than in any other.

Last year attention was drawn, in some technical journals, to the illumination of the private garden of one of our many distinguished Past-Presidents, who,

Figures 1 and 2.

This and the above illustrations show the pleasing effects obtained when St. James's Park was flood lighted by gas, in connection with the International Illumination Congress, 1931.

The installation was specially interesting because of the double problem involved—the illumination of the flowers in the foreground and the lighting up of the distant foliage—and because of the extensive area treated. This rendered it difficult to place the projectors in such a way as to produce the best lighting effect and yet ensure that the sources were screened from the view of spectators.

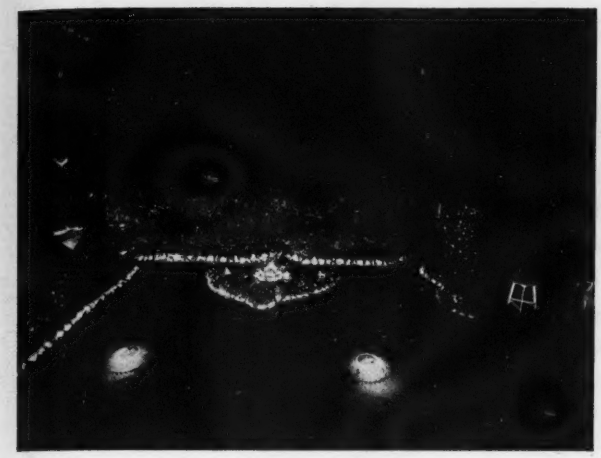


Figure 3. Small garden with luminous mushrooms and spar fringed lily pond.

Figure 4. Artificial ducks—an alternative method of improving the composition on the picture and avoiding monotony.

I understand, made his first essay in this direction nine years ago. About this time other members of the electrical industry were making tentative efforts at artistic garden lighting. The pleasure which my family and I derived from the first few light sources assembled in my suburban garden, in 1932, caused me to replan the scheme and to carry out a series of experiments. As result of these, and experience gathered from other installations, I have been privileged to inaugurate a discussion on the subject.

Mr. R. O. Sutherland, on a recent occasion, told this Society that " the aesthetic sense is a vital essence which must be infused in illumination practice." This applies as much to garden illumination as to the architectural lighting to which he particularly referred.

The words " flood lighting " have been purposely omitted from my discourse because I have strong objection to their use except for edifice, theatrical, and similar applications of light. Floodlighting, in the minds of many, is coupled with a plethora of luminous rays, whether producing flat or fenestration effects, while, to those resident abroad, it is often taken to mean a system of illumination required during periods of inundations, which, fortunately, are more common elsewhere than in the United Kingdom. Floodlighting is also frequently taken to connote a large outflow of money both for installation and maintenance.

It is important to bring home to all who have gardens, whether they be big or small, that the monetary outlay for their permanent lighting, in an artistic and effective manner, is not greatly in excess of that of the radio set of the kind that would be bought for the house adjoining the garden, while the running cost is surprisingly small, but naturally dependent on the charge made by the electric or gas supply authority to its customers for its commodity.

At " Four Winds," in Surrey, an installation consuming over 7 kilowatts, owing to the reasonable figure charged for electrical energy, costs its enterprising owner only sixpence per hour for a domain of four acres.

With gas, the cost is equally moderate. The flowerbed projectors adopted at St. James's Park had 12 mantles, and consumed only 27 cb. ft. (13,500 B.Th.U.) per hour, and emitted a horizontal illumination band of 3,000 c.p.

It has been said that the Daylight Saving Act has so lessened the need of evening light that its provision in the garden is not worth while undertaking, and also that the phenomenal summer of 1933 has given garden illumination undue prominence. Neither of these statements is correct. Daylight saving has increased the public interest in horticulture, and a demand for longer time in which to enjoy, or work in, the garden has arisen. The number of garden lovers and workers is almost beyond belief, and will continue to augment, the cinema is losing its drawing power for want of subject matter, the " open road " is overcrowded and dangerous, the building schemes are providing adequate land for culture, and although commercial, industrial, and intellectual work is more strenuous the hours of occupation are shorter. There are few who do not enjoy the repose and fascination found in the persistent, individual, quiet life of plants of all kinds.

Many people think the annual period of interest in a garden is very short. In this country this is far from being the case. One of the gardens here pictured has a succession of bloom from one Christmas to the next throughout the year. The talented and enterprising owner, Mrs. C. C. Paterson, revealed, in

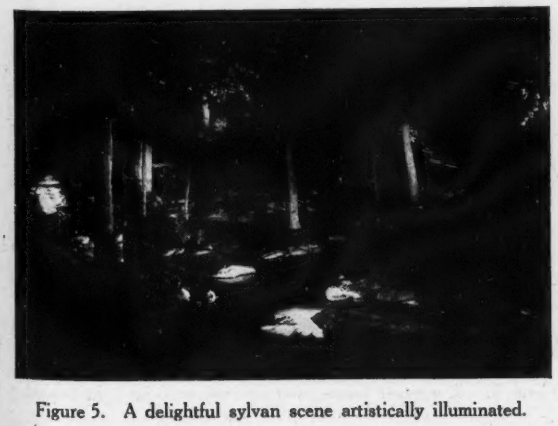


Figure 5. A delightful sylvan scene artistically illuminated.

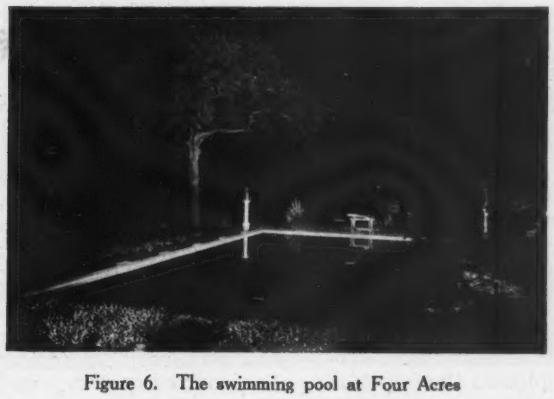


Figure 6. The swimming pool at Four Acres

(*a*) Lamps exposed.

Figure 7.

An ornamental pedestal furnishes an excellent method of concealing lamps, serving to illuminate flowers or foliage. The lamps, with the translucent glass in front of them, should face in the same direction as the spectator. The sheet of translucent glass, shown detached in the left hand illustration, serves to diffuse the light and give the requisite soft effect. Other methods of concealing light-sources by means of objects harmonising with their surroundings will readily suggest themselves to readers of the paper.

(*b*) Lamps shielded.

an instructive article published in February, 1933, in "Good Housekeeping," the floriculture that secured this remarkable result. Evergreens, when artistically illuminated, are also a delight, while when snow has fallen, or hoarfrost has occurred, every garden forms an unforgettable picture if illuminated with either white or coloured light. Mist and rain add to the ever-changing variety of the garden aspect. The advent of bright moonlight permits the disuse of any basic general illumination without spoiling any of the "effects."

The temperature variations, particularly rapid and disconcerting in this country, are easily overcome if use is made of the facilities now available. The window of former times is justifiably being replaced by one with large panes, thus removing the prison-bar impression, and giving instead an open frame through which the garden can be viewed, as a picture, both by day and by night. Panel heaters and radiators suitably placed easily cancel the cold feeling experienced near windows, and eliminate the condensation on them.

From personal experience the author can say that during eight months of 1933 his family enjoyed all its meals, on all occasions when less than six persons were present, whether fine or wet, with all the participants having a direct view of the garden, while when more were present the adjacent dining room, provided with a large mirror, enabled those who could not see the garden to view the trees, many of which were flowering.

This stimulating and health-giving experience was due to a commodious balcony, with adjoining conservatory with abnormally wide panes, now called the "winter garden." The view obtained on a rainy night is now before you. (Fig. 3.) The house, built over sixty years ago, when its present utilisation could not have been contemplated, owes its adaptation to the author's helpmeet, who is the gardener and promoter of this illumination activity.

THE ARTISTIC SIDE.

The subject having been dealt with on general lines, the vital element, the artistic side, can be approached, and it is in this the greatest scope exists. No two gardens are alike, either in size, aspect, contour, arrangement, adjacent edifices or culture, quite irrespective of the climatic, financial, and tenancy conditions, while above all comes the taste and habits of the proprietor and his guests. These infinitely variable factors emphasise the importance of extensive experience and constant touch with horticulture, supplementary to engineering qualifications, on the part of the consulting lighting technician responsible for planning the work. Presupposing this combination of capabilities, there is unlimited scope for enhancing the beauties of every garden by adding new features of fascination and extending its hours and period of enjoyment.

As no two problems are identical, little specific advice, universally applicable, can be tendered, although important generalities, based on experience, are available, and among these, not given in order of importance or merit, are:—

1. Still or moving water is a notable and inexpensive embellishment. (Fountains and cascades will not be dealt with in this discourse; their technicalities are such that an opportunity for their discussion must be

Figure 8. A summer house, with diffused artificial light behind the trellis work in the background.

sought on another occasion.) No branch of display lighting has made more progress in the last two years than polychromatic jet lighting, and I am moved to interject here the hope that Trafalgar-square, London's ideal show-place, may have luminous fountains, in keeping with its importance as centre of the Empire, adding colour to a dullish surround.

2. If a cascade, or dripping water, form part of the scheme it is desirable to let the water fall from a sufficient height to make a perceptible sound as well as to arrange for a background with not too poor reflection factor, and to have incident light at such an angle that surface reflection from the water is visible.

3. A high degree of brightness should be avoided, especially for the basic general lighting of the area, as, apart from destroying the idyllic impression desired, all special effects are rendered more difficult to secure in sufficiently notable contrast.

4. The light emitted by the gas-filled electric lamp, of good quality and operated at standard pressure, or from the modern high efficiency gas mantle, although both are in some degree colour-distorting, is suitable for the majority of purposes. Where, however, the coloration of flowers or foliage are of unusual importance modifying devices securing either " daylight " or " semi-daylight " illumination can be used with advantage.

5. Coloured light, however obtained, is a valuable, and where colour filters are used, a rather expensive, tool, but is requisite for accentuating foliage or flower tints and producing illusions.

6. When light-toned statuary is present, lights of suitably contrasting colours projected from opposing directions, blending on the object, can add beauty and interest.

7. Large stones and boulders of light shade, or preferably white like Derbyshire spar, brighten the picture and show up outlines of beds, and may for fantasy purposes be picked out in places, with coloured light.

8. Lily ponds, lagoons, or swimming baths add to the scene, whether lit by immersed or projected light or that reflected from neighbouring growths or objects. Swimming pools, when fitted with immersed luminaires and overhead light sources of moderate intensity, constitute, when in use, a moving picture of unexcelled fascination.

9. The directive capability of artificial light can be used to vary the artistic appeal of any item from that it possesses in daytime. The picture of a statuette in an alcove, is a good example of this. (Fig. 9.)

10. The limited height of the light sources often produces contrasts only observable after sundown. If too low, what has been described as " the motor-car-headlight appearance " is given to grass and short plants, and, consequently, one of the pioneers in garden illumination, as well as in electro-culture. Mr. Borlase Matthews, illuminates his lawn by rays projected at right angles to the usual line of vision.

11. Shadows must be controlled in intensity and direction, as if properly treated they form valuable and costless additions.

12. The illumination of lawns can be made an interesting feature. At the Chicago Century of Progress Exhibition in 1933 " mushrooms " with an almost opaque hood, with reflectors below, gave a stratum of, non-glare, low-level, light over the extensive lawns. The author has modified this conception by converting the " mushroom " into a gorgeous flower that has a highly decorative effect.

13. The sameness of lawns may also with advantage be broken up at night by single-sided or double-sided pale-tinted flat-surface figures that can easily be moved, or removed, that add novelty to the scene.

14. In the garden of the Ideal Home Exhibition of 1933 a miniature house with a coloured lamp inside improved the attractive quality of one of the exhibits. Whether habitable or miniature an illuminated garden house is a decorative and useful addition. If habitable it can be used in all weathers, being stove-heated

Figure 9. Statue in alcove with illumination from submerged luminaire.

if necessary, and the owner secures a different restful view of his territory.

15. Many plants bear flowers only during a short period; fruit trees, like the almond and " flowering " pear, blossom early in the year, the rhododendra and azaleas are also early flowering and yield their abundant tinted beauty only for a limited time. Portable luminaires, of inconspicuous easily blending appearance, should be available for making the best of these fleeting treasures.

16. Although there should be no extravagance more care can justifiably be given to secure picturesque re-

Figure 10. A garden effect. Gnome fisherman on a rockery.

sults than high efficiency. It is better to do part of the garden well than attempt the whole, when the outlay is restricted.

17. Most definitely in garden illumination " true art is to conceal art ": the light sources should almost invariably be concealed and the illumination should be definitely purposeful.

18. Where unexpected level differences exist a small light can both indicate and ennoble them.

19. For the cultivator the opportunity of working at any desired time is of considerable value. The cool of the evening in summer, the dark hours of winter, may be his main opportunities for cultivation, and for this a good general light, or a portable local light, should be provided.

20. If the garden may be considered to extend indoors the illumination of winter gardens, conservatories, and individual plants gives much scope for ingenuity and permits the use of apparatus unsuitable for outdoor purposes. A combined lighting and potholding standard will enable plants to thrive remote from windows, as they will benefit both by the light and the warmth emitted from the lamp.

THE PRACTICAL SIDE.

From the foregoing it is clear that there is an interesting and valuable field for the illuminating engineer in this utilisation of artificial light, and it is therefore desirable that the technical side should be considered.

Dealing with electric light it is reasonable to assume there are millions of houses throughout the country that either have now, or will in the near future acquire, an electric supply and so that side of the question needs no consideration.

The carrying of the conductors from point of entry to those of utilisation will, like the illumination, depend on individual circumstances. For small gardens or courtyards the luminaire may be attached to the house, but where extensive areas have to be lit the conductors may sometimes be carried overhead. Wherever feasible a permanent underground skeleton supply network is advisable. This should be arranged to feed conveniently placed distribution centres, from which semi-permanent or temporary conductors can be taken.

Underground conductors insulated effectively with dielectric not attacked by the corrosive soil constituents are now obtainable, and may be safely used in all protected situations. Consideration must, however, be given to the forcible entry of pick and shovel.

As a mechanical protection rain-water piping coated with preservative answers well and is quicker laid than earthenware pipes. Where extra risk is involved a creosoted stout warning board should be placed above the piping. Laid at two spits' depth the cabling work is quickly done.

The outlets from the network, placed in convenient but concealed positions, should be supported, and protected, by a cement concrete surround, well above ground level, and should terminate in stout connector sockets under cover.

When required, a distribution unit, with a number of sockets for sub-distribution, can be connected to the outlet socket, and from this the actual lighting conductors will run.

The semi-permanent conductors, that is to say those that will remain in a given situation at least a whole season, must be suitably protected against mechanical damage, and can be attached to whatever will remain fixed as long as they are required. The temporary conductors may remain visibly exposed and, where there is grass, partially protected by lifting sods and slipping the twin wires under.

The permanent network should have ample current capacity, as at any time the demand may be increased for special lighting and even for soil heating.

Switching, except indoors controlling the main circuits, is rarely needed. It is better to withdraw plugs

Figure 11. A lovers' bower.

from their sockets to secure any variations desired in the illumination, together with double-pole isolation in case of emergency.

So far as I know there are no regulations affecting this class of wiring, the sole guide being experience and common sense added to sound knowledge of wiring work.

Not being a gas engineer, I cannot speak with authority on gas distribution, but from my experience with modern fuel gas utilisation I see no difficulty in arranging a supply system, similar to that outlined for electric current, even down to the easy attachment of rubber-coated flexible pipes of small dimension.

The luminaires must inevitably be as diverse as the installations. They may be required at any level from that of under water up to the eaves of the residence, while their light emission may be required concentrated, dispersed, or restricted. They may be merely weatherproof or, of necessity, stormproof, and even submersible, but, above all, they should be inconspicuous. For electric luminaires mirror-backed glass and vitreous or hard-bake enamel of correct quality have proved satisfactory for exposed positions, while for enclosed luminaires, metal with treated surface has proved cheap and adaptable. Occasionally translucent glass panels are required. As much of the success in their use depends on the direction of the incident light, the provision of hinges or gimbals is desirable.

I have found difficulty in securing a source of supply of suitable luminaires, and have, therefore, generally built them, with small exception, in my experimental workshop, using glass and metal components purchasable on the open market. It may be in the future standard patterns will be readily obtainable.

The protection and disguising, or concealment, of the luminaires require care as well as experience. Where electric light is used, the smaller volume of heat present is an advantage, as the luminaires can be placed almost anywhere among foliage, or in such unexpected places as bird boxes, but with this source of energy the influx of moisture must be carefully guarded against. The inclusion of electric luminaires in cement or earthenware housings with or without surrounds of stone makes good permanent work on the ground level.

The stillness of the light source adds to the charm, but I have found the use of a few twinkling neon gas-

filled lamps useful and attractive among dark surroundings.

The six patterns of luminaire used by the Gas Light and Coke Company in St. James's Park are illustrated and fully described together with distribution curves and other data in a booklet prepared at Watson House for the 1931 Congress, and need not be detailed here. The perseverance, skill, and sound knowledge utilised in the construction of these devices make this booklet of exceptional value to illuminating engineers.

Spilled light may cause disappointment when the luminaires are fixed among foliage, and both the provision of visors, or " cut-offs," and trimming of the trees may be necessary.

ILLUMINATION DATA.

The illumination intensities for private gardens need not be high, as they are not in competition with bright public lighting, and the following figures given by D. W. Atwater and Alfred Paulus, based on a large experience in the United States of America, accord with my own:—

	Ft.-candles.
Flower-beds and Rockeries	0.2—0.4
Trees and Bushes	0.2—0.4
Backgrounds, such as Trellises and Walls	0.1—0.2
Statuary	0.5—1.0
Pathways	15 watts for 20 to 25 ft. run
Ponds	2 watts per sq. ft. surface
Single-jet Fountains	15 watts per ft. height of jet
Steps and points where the incautious might trip	a 15-watt lamp is adequate

It has not been possible to gather data from the few illuminated gardens in this country, and what occurs in my own rectangular garden of 3,200 sq. ft. is therefore tabulated:—

	Watts.
General basic illumination, sufficient for reading in most parts, from one source 25 ft. and two 12 ft. above ground level, aggregating...	300
Effects.	
Uncoloured Lamps	225
Flame Coloured, sprayed external	60
Yellow and Green, internal sprayed	80
Neon	10
Total	675

In addition, a portable directional standard mostly used for gardening work adds another 100 watts, the total demand being, therefore, ¾ of a unit per hour, at the rather high cost of 2½d. per unit.

The garden is adequately and very pleasurably illuminated by the effect lighting alone, but the addition of the general lighting shows up the trees and bushes in the neighbouring gardens, enabling foliage as distant as 75 yards to be added to the view and glamour of the outlook. The neon tube illumination of a cinema, a mile distant, gives a pleasant glow above the trees, some of which are 45 ft. high.

In the United States statistics show that the average minimum connected load for garden illumination is about 250 watts, while the average high load is 2½ kilowatts. Mr. Paulus gives the following details of how this higher load is generally used:—

	Watts.
5 Underwater or Fountain Units	1,250
2 Gateway or Entrance Units	50
2 Small projectors for Statuary	200
20 Ornamental 5-watt lamps	100
1 Projector under the Eaves	500
1 Colour Projector for Tulip or Similar Beds	250
Total	2,350

Half of this load, it will be noted, is for water effects, and there are many small lamps and a few large projectors; the reason for this allocation I cannot state, but it differs from my practice, no doubt due to local conditions.

Endeavour has been made to obtain particulars of any difficulties encountered by others in carrying out garden illumination installations, but nobody has admitted any. This does not mean that none exist, but perhaps it entitles me to say that those who have accomplished this kind of illumination work have been masters of their craft and possessors of wide experience. Personally, I have had but few disappointments, and found no difficulty in the maintenance during the two years I have worked in this field, and do not anticipate the future to be notably different from the past.

LIGHT SOURCES.

Particulars of the light sources have not been given specifically, as it has been assumed that the audience is well acquainted with whatever is available. It is conceivable that the rare gas discharge lamps, with and without hot cathodes, will play an important role where colour washes are desired on a large scale coupled with high efficiency.

Phosphorescence and fluorescence can also be used for effects, particularly in private gardens, where the basic illumination is low. Suitably coated surfaces will respond to the invisible ultra-violet rays.

THE ELECTRIC GARDEN.

It has already been suggested that the wiring should be installed ample for additional load. Some of this may be in extending the use of light, but much of it can be used for soil heating, now quite a simple matter, since special cable units are made for lying direct in the ground and coupling across the standard low voltage supply.

Recently the electrification of the garden has taken a step forward, due to the experimental work of Professor S. S. Nehru, and described by him in a lecture given last November at the Society of Arts, printed in No. 4,234 of the journal of that society.

The object of Dr. Nehru's research was primarily to find an inexpensive method of conferring the advantages of electro-culture to agriculture at a reasonable outlay for installation and maintenance, but has extended during the several years it has been conducted to the study of electrical influences on very many seeds, plants, and flowers.

This subject is mentioned here as, when providing conductors for light, those for electro-culture can be added inexpensively.

CONCLUSION.

Having now opened the subject for discussion, I will show examples of garden illumination that did not fit into the body of my discourse, and accompany them with comments, but before doing so desire to thank those who have enabled me to show lantern slides, supplementary to my own, namely, the Gas Light and Coke Company, the General Electric Company, the E.L.M.A. Lighting Service Bureau, the Edison Swan Company, Messrs. D. W. Atwater, H. H. Berry, P. Good, H. Marryat, Borlase Matthews, Alfred Paulus, L. A. S. Wood, and the editors of " Homes and Gardens " and " Good Housekeeping."

Finally, I desire to add that my impression is that there is a vast field for the illuminated garden in the United Kingdom and the tropical parts of the British Empire, the cultivation of which should bring both profit and pleasure.

[*We shall be glad to hear from any of our readers who have experimented with the illumination of gardens at night, or who have had personal experience of the use of artificial light as an aid to horticulture.*]

The Art and Practice of Garden Illumination

DISCUSSION

Mrs. C. C. PATERSON, in opening the discussion, explained that she was only what might be termed "an engineer by marriage," and was therefore not really competent to deal with the technicalities of this subject. She had, however, listened with much interest to Mr. Eck's able lecture. There were two or three points that seemed worth mentioning from the standpoint of the ordinary woman, and one or two ideas that had occurred to her as likely to help to make the illuminated garden appreciated by women. Mr. Eck had touched upon the question of the value of illumination to gardeners. The ordinary business man had little opportunity to attend to his garden during the winter months except during the week-end, and was therefore apt to think that it was hardly worth his while to take much trouble with it. In these cases an illuminated garden offers a new hobby during the winter months. Actually there were now many winter plants, flowering shrubs and evergreens which could be obtained to make the garden almost as beautiful in winter as in the summer. By their aid a pleasant outlook from the house could be readily secured.

From the woman's point of view an illuminated garden should be considered almost as important as the furnishing of the house. In the winter evenings it was usual to draw the curtains over the window. Everyone gathered round the fire and were only interested in the four walls. With an illuminated garden the curtains could be left open, giving a beautiful view of the garden, and the room seemed then to become much more spacious. The introduction of mirrors in a small room, reflecting the scenes from the illuminated garden, could make the room seem almost palatial, and with their aid one could obtain some beautiful effects.

Then again, from the standpoint of the hostess—an illuminated garden is a great joy to one's friends. One Christmas when they had quite a large party a very attractive view from the window was experienced. Father Christmas was seen emerging from an apparently distant wood, travelling on a sleigh. He was first seen travelling towards the window in and out of the trees, then gradually coming nearer and nearer, and finally galloping up to the house and distributing his presents. With a small expense and a little trouble one could plan quite attractive devices for the purpose of entertaining one's friends.

Mr. W. H. JOHNS said he was very pleased to receive an invitation to this meeting. Those who, like himself, were engaged in park work, were very definitely and seriously handicapped so far as evening work is concerned during the winter months. It would be a great advantage if lighting could be provided to enable park work to be carried on after dark, and if it were possible to get a really efficient and adequate illumination to enable Londoners to play games in parks at night instead of wandering about the streets. He had suggested from time to time to his Committee that this illumination might be provided during the winter, but the question of expense was regarded as a formidable one. Furthermore, it might also be difficult to get the workmen to work on the cold winter nights when they would rather stay round the fireside.

One thing that struck him in some of the slides (which might, however, have been a defect in the photograph) was the unnatural effect of the picture—for instance, the trunks of the trees did not look a bit like tree trunks. An artist liked to see broad shadows. The illumination was too bright and there were apparently no shadows.

As regards work in public parks the illumination should be adequately distributed so that there were no dark places. He knew that all those connected with park work would like bright illumination and the feeling of security which it gave. There was also the problem of the park staff. At present the work was badly balanced, i.e., they had to employ extra men in the summer, but only about half were needed during the winter months. If artificial illumination could be provided possibly a full staff could always be kept on.

Another point was in regard to the effect of light on tree growth. He had found that in the case of a tree that had an electric light standard very close to it, its growth was increased and it kept its leaves much longer. This happened in the case of all the trees in his borough, not only in one case.

Mr. BORLASE MATTHEWS said he thought it was well from time to time to review subjects, and this paper seemed to be the first general review of this particular topic. There had been shown many excellent pictures, some particularly interesting. It appeared to him that a new note had been struck in what might be called "engineering art." The development of the picturesque side of the work added interest to electrical engineering. There seemed to be a great scope here for the illuminating engineer in this field. It was not merely a question of putting flood lights in a garden. Much thought in regard to the arrangements of these lights was necessary. One had to make sure that one did not get a flat effect owing to too much light or misplaced lights. One must bear in mind, too, that people not only liked to look at the garden but to walk in it also! For instance, one might arrange things so that a delightful picture was seen from indoors, but might be blinded by the glare when one actually explored the garden.

Mrs. Paterson had remarked on the beauty of the view of an illuminated garden as seen from the window. This reminded him of an enterprising man in Chicago who, he believed, had made a fortune out of a scheme which embodied a sort of illuminated artificial garden, placed in the window after dark. The device was specially acceptable to occupiers of flats which had a dreary outlook—possibly blank walls of adjacent buildings. The idea was now a familiar one and examples could be seen in London.

One might go a step further and consider the illumination of greenhouses and the use of light for the culture of plants. The effect was to cause the flowers to open earlier. A considerable amount of work in this connection had been done, and likewise in connection with the stimulation of germination of seeds by electric light. Successive treatments with only a few hours' exposure to artificial light had worked wonders in this direction; for example, in the treatment of transplanted seedlings, and in controlling the flowering period so that blooms might be at their best on a certain day. From the standpoint of the market gardener who had to make sure that flowers were at their freshest and best on Easter Day or for an exhibition this possibility was of great importance. Naturally plants varied in their response to light. Azaleas in bud, put under strong artificial light at night, might be found in full bloom the next morning! He recalled the experience of a man who left a plant in part shadow, with the result that next morning half the flowers were in bud and the other half in full bloom!

Mr. Borlase Matthews also gave some of his own experiences in the treatment of strawberries, with which he had been experimenting for years. Strawberries produced in January were naturally expensive—fetching as much as 45s. a pound wholesale and £5 retail. Yet they had commonly very little flavour.

He had found, however, that the flavour was good and the fruit was sweet if the plants had been forced under artificial light.

Mr. Eck had briefly referred to applications of ultra-violet light—he presumed for decorative purposes only. He himself had not found that this form of radiation of great benefit in the cultivation of plants. Neon tubes, however, might be advantageous. In conclusion, Mr. Matthews recalled that lead covered cables exposed to air and moisture were liable to deteriorate and needed protection.

Mr. H. CHEVALIER said he understood that Mr. Sutherland was going to speak—and as they held opposite ideas on the subject he hoped he would! He was glad to see that Mr. Eck showed in his slides some examples of an illuminated landscape, but these were shown from the worst end. Illuminated landscapes were popular at seaside resorts where, however, strange things sometimes happen and difficult conditions were often encountered. He had been working for the past three years on the coloured floodlighting of gardens and rockeries. In one case a large area had to be viewed simultaneously from different directions, and there were also practical difficulties. During the first year he used 300 kilowatts, but found the results very sketchy and the flowers had a lifeless appearance. During the second year he doubled the illumination, but the result was not much better. The glare trouble already referred to by one speaker had been a difficulty, and the selection of positions for lights was complicated by the fact that the place could be approached from so many different directions. Ultimately, in the third year, he placed the lights at the base of the trees rather than at a distance, and found that this solved the difficulty, leading to a very pretty effect. Other problems he had encountered had been the placing of coloured lights so that the beams did not cross, and the avoidance of undue heat from the lights which was not always good for the plants. Another problem was besides adequately lighting flowers and trees one had also to remember to light the pathways—otherwise accidents were liable to occur! This difficulty might be overcome by the use of mushroom fittings, located only three feet from the ground. The problems involved in this form of lighting, which was of considerable value to seaside towns, were different from and in some respects more difficult than those encountered in private gardens.

Mr. R. O. SUTHERLAND said he had listened to Mr. Eck with great interest, the more so because he recently had the privilege of addressing the Landscape Architects on this subject. To have had the engineer's standpoint thus expressed was extremely valuable, as it helped to make up the deficiency in his own line of thought. The subject of garden lighting should, he thought, be approached in much the same manner as the lighting of buildings. The lighting of gardens should form part of one's complete scheme—but the difficulty was that gardens took some time to mature! The chief attraction of garden lighting did not lie in masses of vari-coloured lights, but rather in the careful selection and treatment of different vistas. Too much attention was apt to be paid to too many points. He thought that garden lighting should be approached by selecting a number of attractive pictures and concentrating on them.

Mr. Sutherland said he had noted that Mr. Eck objected to the term "floodlighting," and he thought him perfectly correct in doing so—because unfortunately people thought of floodlighting as something rather dazzling or garish. Floodlighting was now becoming more refined. The idea of treating gardens with a mass of light was quite wrong.

Mr. Eck had remarked that the technician should be one fully capable of dealing with all the technique. This was very true. When planning lighting schemes every point must be studied, hence the value of silhouette—a form of effect often well adapted to the display of shrubs and the foliage of trees. What Mr. Eck said about not attempting too much at once was also to be commended.

Water lighting was a most interesting subject. The application of a small bridge in order to get light on the water was a good idea. In treating surfaces of water, the angle from which light was received was often of importance.

The idea of extending the garden into the house and on to the roof was also a promising one. Much interest was being taken in modern architecture; and in the houses of the future roof gardens, where many pleasant hours could be spent, might be a regular feature.

Mr. C. C. PATERSON said that they were indeed indebted to Mr. Justus Eck for bringing this subject before them in such an interesting and charming way. It seemed to him an exceedingly difficult problem, and he was much interested to hear of what was being done and to observe the attention that was now being paid to the subject. His own experience was limited to domestic gardening. Those who had not lived with an illuminated garden perhaps did not realise the great difference between a garden in the daytime and a garden illuminated at night. A garden lit up at night had beauty of its own. One should not try to illuminate it so as to imitate daylight, but rather leave it as a garden illuminated by light. One of the chief features was that the colours looked so different. Flowers that were dusty and past their prime during the day took on an entirely different aspect, and their beauty was enhanced when illuminated at night.

Mr. Eck had raised the question of the amount of light for a private garden. He himself had used two 750-watt floodlights. These provided ample light for the foreground. Lantern slides, one must admit, were often ineffective things. He did not know anything that did so little justice to the actual scene as a night photograph. Mr. Paterson said he thought this paper and discussion well worth while, and hoped that it would draw attention to this branch of engineering, which anyone could take up but which at present was so neglected.

Mr. JUSTUS ECK, in response, desired to thank everyone for the kind reception his discourse had received and for the additional information imparted in the kindly criticism (with most of which he agreed, as would be observed when the paper appeared in print) and said that the opening of the discussion by Mrs. C. C. Paterson, was a great compliment and displayed what an "engineer by marriage" could accomplish. The presence of Mr. W. H. Johns added much to the occasion, for his was the wider outlook that dealt with parks rather than gardens. Park lighting in our densely populated centres must come before long, and in fact a scheme was in course of preparation for the illumination of the largest of London's many parks, in 1931, when the financial crisis pushed it into the background. One had only to think of the wonders of Kew Gardens, lost to many by the early closing, and the beautiful effects achievable there without any detriment to the culture, to feel sure that it was only a matter of time for all public parks to be adequately and artistically lit. Mr. Johns rightly criticised the lantern slides for, as he pointed out, no photograph could exhibit the charm of the picture visible to the living onlooker. The effect of light rays on growth as mentioned by him was worthy of note.

Mr. Borlase Matthews had contributed a mass of information, based on his extensive researches in electro-culture, and accompanied it with artistic suggestions that would, he was confident, receive acceptance from many. He was glad that Mr. Matthews had emphasised the proper placing of the luminaires so as to make the illuminated garden not merely a view from the residence, or garden house, but also a delight to walk in with safety. It was in this direction that the illuminating engineer, as contrasted with the "plumber electrician," easily proved his worth. Mr. Chevalier spoke with an authority, based on extensive experience in public gardens, and his difficulties were

fully appreciated by those who had had similar problems laid before them for solution. The lighting of the grounds of the Chicago Exhibition last year (and, he believed, maintained as before this year) formed a valuable contribution to the subject of outdoor illumination of pleasure resorts with glare-free result. What Mr. R. O. Sutherland had said coincided with his views, most especially when he said "that garden lighting should be approached by selecting a number of attractive pictures and concentrating on them"; this was his (Mr. Eck's) almost daily experience.

Mr. C. C. Paterson's statement that "a garden lit up at night had a beauty of its own" showed that after nine years of experience in garden illumination his appreciation of it is as keen as ever. He thanked him for pointing out that the appearance of the flowers and leaves when past their prime was rejuvenated by artificial lighting. By the use of slightly tinted mirror glass in the luminaires he had been able to obtain what looked like "superior-to-daylight" effects with but a very small loss of light and by stronger tinted filters to enhance definite colours with the changing seasons.

Mr. Eck concluded his remarks by impressing on all the beauty, utility, and low cost of garden illumination and the importance of embodying in it artistic merit.

The Illuminating Engineering Society

Silver Jubilee Commemoration (1934) Award.

As members of the Illuminating Engineering Society and readers of this Journal are aware, a Leon Gaster Memorial Premium of Ten Guineas is awarded annually for the best paper read before the Society.

A new step—expressly intended to encourage the younger members of the Society—has now been taken by the Council in commemoration of the attainment by the Society of its Silver Jubilee this year. For the award of this newly established premium only members of all classes or affiliated students who are under the age of twenty-six years are eligible.

Achievements during the coming session complying with the stated qualifications should be reported to the Hon. Secretary. We hope that in this way material worthy of publication or presentation at meetings of the Society will be brought to light, and that the Council at the end of the coming session will have the pleasure of making the first award under this new scheme.

The conditions under which the award is to be made are, in essence, as follows:—

1. A Silver Jubilee Commemoration Award shall be available every year, unless otherwise determined for a Member, or Associate, or an Affiliated Student of the Society, who is under the age of twenty-six years on the date of his qualification for the Award.
2. The Announcement of the Award for the previous Session shall be made by the President at the Opening Meeting of the next Session of the Society.
3. The Award shall consist of:—
   (a) An inscribed Diploma, stating the reason of the Award, signed by the President and Honorary Secretary.
   (b) The sum of Five Guineas by a cheque drawn on the Society's Bankers.
4. The Qualification shall be the accomplishment of any of the following tasks:—
   I. The presentation in writing to any Technical Society or Association, approved by the President, of a paper dealing with the theory or practice of Illuminating Engineering.
   II. The design and/or construction of a novel instrument or appliance for use in connection with any application of, or research concerning illumination.
   III. The carrying out by the applicant of an investigation beneficial to Illuminating Engineering.
5. The decision as to the recipient of the Award is to be in the discretion of the President, acting with the advice of the Council.
6. In the event of no response of sufficient merit being forthcoming in any Session no Award in respect of that Session shall be made.

Association of Public Lighting Engineers

Eleventh Annual Meeting and Conference, Aberdeen, September 17—20

We have before us the Provisional Programme of the above Conference, which promises to be a very agreeable one. Aberdeen is a most interesting city. The surrounding scenery is magnificent. The holding of the biennial Exhibition of Public Lamps and Lighting Appliances indoor is to be supplemented by demonstrations of public lighting and floodlighting out of doors. The Inspector of Public Lighting, Mr. Alexander Forbes, is doing everything possible to render the gathering interesting and enjoyable. We hope that there will be a large attendance, not only of members of the Association, but of representatives of public lighting authorities and others interested in the cause of better street lighting, all of whom are free to apply to join the Conference as delegates (fee £2 2s.).

The programme provides for an official reception at the Art Gallery on the opening evening.

On the following morning there will be an official welcome, and the Conference will be formally opened. The new President (Mr. Alexander Forbes) will be inducted and will deliver his address, dealing mainly with the lighting of the City of Aberdeen. A paper on Lighting Department Practice and Equipment, by Mr. J. M. Ward and Mr. J. Mann, will complete the morning's programme.

In the afternoon a method of predetermining illumination in streets will be demonstrated by Mr. W. J. Davey, following which Mr. J. S. Dow will give a brief account of the exhibition, which will then be thrown open to members and delegates. (The exhibition will be thrown open to the public on the following day.) In the meantime, an excursion for the benefit of the ladies will be arranged.

In the evening a feature will be the Association Supper and Dance in the Beach Dance Hall. This is the first function of the kind arranged by the Association. It is, therefore, hoped that members will help, by bringing their womenfolk, to make it an outstanding success.

On the morning of the Wednesday (September 19) the Annual Meeting will be followed by a paper on the Technical Aspect of Recently Developed Street Lighting Fittings by Dr. S. English, after which members and delegates will be entertained to luncheon by the Corporation Gas and Electricity Departments.

In the afternoon papers on the Design and Application of Traffic Signals (Mr. C. H. Woodward), Road Surfaces and their Influence on Public Lighting (Mr. P. J. Waldram), and a new Lighting-up Table (Mr. G. H. Wilson) will be read.

In the evening there will be an opportunity of inspecting the public lighting and some examples of flood lighting by gas and electricity.

On the final day (Thursday, September 20) there will be no Conference business, but a motor coach excursion through beautiful scenery to the famous Linn o' Dee and back is being arranged.

Methods of Testing the Suitability of Colour Filters for Use in the Photometry of Electric Discharge Lamps or Other Sources of Coloured Light

By
G. T. WINCH, A.M.I.E.E.,
E. H. PALMER, B.Sc.

(Communication from the Staff of the Research Laboratories of The General Electric Company, Limited, Wembley, England)

1. Introduction.

The development of electric discharge lamps has focused considerable attention on the various possible methods of measuring them. In one method (1), which has much to recommend it, the colour difference in the photometer is reduced to a minimum by means of filters. In order to accomplish this, transparent coloured filters are used to modify the light from tungsten lamps, and the filters must be chosen such that the spectral energy distribution of the transmitted light approximates closely to that of the coloured light source. It is possible to find filters which will enable an apparent colour match to be obtained by one observer, although the spectral *energy* distribution of the light transmitted may be appreciably different from that of the coloured light source. When modifying the energy distribution of tungsten lamps to match that of discharge lamps, a difference in the energy distribution is almost inevitable, as the former has a continuous spectrum and the latter a line spectrum. The colour match obtained in this manner might be termed a synthetic colour match. Whilst with such a filter a particular observer might consider the two sides of the photometer to be matched for colour, other observers would generally see a slight colour difference between the two sides of the photometer field. This occurs because of the differences in the colour vision of the observers. If modified tungsten radiation is to appear to all observers identical in colour with that of the coloured source, the filter used must have a spectral transmission such that the transmitted light is identical in its spectral energy distribution with that of the source to be measured. As in practice it is extremely difficult, and often impossible, to make a filter having a specified spectral transmission, a compromise must usually be made by selection from the various available media.

In the case of the light from electric discharge lamps it can scarcely be hoped to imitate exactly their spectral distribution by filtering the light from tungsten filaments, and therefore some difficulty in interpreting the spectral data will always be present.

Because of the laborious nature of the spectrophotometric method, combined with this difficulty of interpretation, the authors have used a much simpler method, which is satisfactory in practice.

2. Photometric Method for Selecting Filters.

The principle involved is based on the method developed by Ives (2) for correcting the errors introduced by individual observers when a colour difference is present in the photometer field. Ives developed yellow and blue filter solutions, both of which have equal integral transmission for the light of a carbon lamp operating at 2077° K. estimated by the hypothetical average eye, as specified by the internationally agreed relative luminosity data. The ratio of the transmission of these filters measured by any observer, subsequently referred to as the Y/B ratio, is directly related to the departure of the respective observers' results from the true value as determined by the hypothetical average observer, whose Y/B ratio would obviously be unity.

Ives has shown that when individual observers' readings are plotted against their Y/B ratios they fall on a line, the slope of which is dependent on the colour difference between the two sources being compared. If there is no colour difference this line is horizontal.

This is illustrated in Fig. 1, where some filter transmission data are plotted. These particular filters, when used with tungsten radiation, introduce colour differences equivalent to those between tungsten lamps operating at different temperatures, and it will be seen from Fig. 2 that the slope of the line connecting differences in measurement with the Y/B ratio is related to the equivalent temperature difference introduced by the filters. It is interesting to note that these results are in close agreement with the results obtained by Crittenden and Richtmyer (3), which have been plotted on the same curve, and will be seen to fall on the same line within the accuracy of measurement.

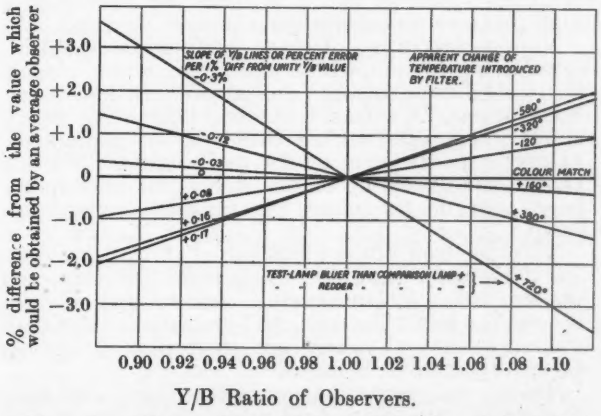
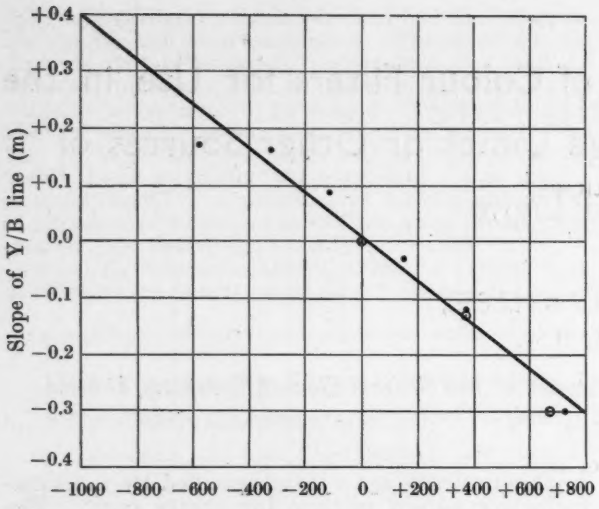


Figure 1. Diagram showing the mean Y/B Slopes obtained by Lummer Brodhun Contrast (6° field) and Guild Flicker Photometer when measuring the transmissions of filters introducing apparent temperature differences between comparison and test lamps.

The degree of consistency with which photometric balances can be made in the presence of a colour difference is largely dependent on the type of photometer head used, and it has been shown that whilst the Lummer Brodhun contrast type of photometer is the most precise when comparing sources identical in colour, a flicker photometer used under carefully

(1) Buckley. Ill. Eng., April and May, 1934.
(2) Ives and Kingsbury. Trans. I.E.S., Vol. 10, 1915, p. 203.
(3) Crittenden and Richtmyer. Sci. Papers of Bureau Stds. No. 299, p. 100. Also Trans. I.E.S., Vol. 2, 1916, pp. 331-366.



Apparent temperature differences introduced by filters (colour temperature of tungsten source 2360°K).

⊙ Indicates readings taken from Sci. Papers of Bur. of Stds. No. 299, p. 110 by Crittenden & Richtmyer.

Figure 2. Relation between slope of Y/B line and apparent temperature differences introduced by filters.

specified conditions yields the most consistent results in the presence of a colour difference.

It follows from Ives' work that if a filter is inserted on the comparison lamp side of the photometer head, such that the transmitted light is identical in spectral distribution to that from the discharge lamp, then all observers will make a photometric balance at the same point on the photometer bench. If, therefore, the individual observers' results are plotted against their respective Y/B ratios, the points will be on a horizontal line. Similarly, if the filter does not fulfil this condition, the results when plotted against the Y/B ratios will yield a sloping line, and the slope will depend on the degree to which the filter departs from this requirement.

3. Experimental Procedure.

Preliminary inspection will indicate that a bluish-green filter is necessary to modify the light from a tungsten source so that it matches the light from a high pressure mercury vapour lamp.

Various specimens of glass, gelatine, or liquid filters having colours within the range, which inspection indicates as suitable, are prepared in convenient sizes for test. A normal horizontal photometer bench suitably equipped with a Guild flicker photometer (2 degree field) is set up for the purpose. The discharge lamp is set up on one side of the photometer head, and on the other the tungsten comparison lamp.

The specimen filters are inserted in turn between the photometer head and the comparison lamp, and photometric measurements made by several observers against the coloured light source. The individual observers' values are then plotted against their respective Y/B ratios.

Should the results for one of the filters used with the comparison lamp yield a horizontal line in this diagram, then that filter is the one required, and the operating temperature of the comparison lamp is simultaneously determined. In general, none of the lines will be found to be horizontal. However, if different thicknesses of the specimen filters which yield lines of small slope are used in combination with the comparison lamp operating at different temperatures, the best combination may be found.

It is clear that this method involves a very large number of observations, and it will not be possible to estimate whether or not the particular type of filter investigated is likely to give a suitable approximation until all the measurements are completed.

4. Simplified Photometric Procedure.

Because of this difficulty, the authors used a modification of the method, which, whilst suffering from the limitations imposed by the use of a Lummer Brodhun photometer head, had the advantage that considerably fewer measurements were necessary. By observation of the colour contrasts in the photometric field, the suitability of a specimen could be estimated at an early stage in the investigation.

Following preliminary inspection, samples of the glass chosen for investigation were prepared in four thicknesses. The photometer was set up as before, but with a Lummer Brodhun contrast photometer head. Instead of the observers making photometric balances with the comparison lamp operating at a fixed temperature, each observer adjusts the volts on the comparison lamp to give the nearest approximation to a colour match.

The results so obtained are shown in Fig. 3, where the temperature of the comparison lamp is plotted against the Y/B ratios of the observers for each thickness of specimen. It will be seen that the nearest approach to the horizontal occurs at a thickness of c.4 mms. It is essential that the approach to horizontality is accompanied by minimum departure of the individual observations from the best line through them, the degree of variability in the results being measured by the coefficient of variation of the errors from the line.

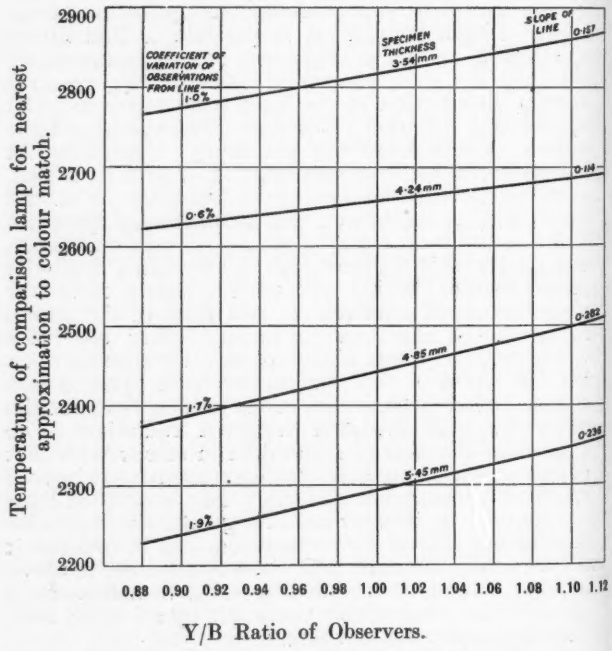


Figure 3. Diagram showing the relation between the temperature of the comparison lamp and the Y/B ratio for different thicknesses of specimen.

Had more than four thicknesses of the filter been tested, this selection could have been further improved by plotting two curves:

(a) The slope of the Y/B ratio-temperature relationship against the thickness of the specimens. This usually indicates the existence of a minimum slope, and the thickness corresponding to this minimum is the most suitable thickness of this particular type.

(b) The temperature for unity Y/B (from Fig. 3) against the thickness of the specimen. The temperature at which the comparison lamp should be operated is then given by the point corresponding to the thickness determined from curve (a).

Literature on Lighting

(Abstracts of Recent articles on Illumination and Photometry in the Technical Press)

(Continued from page 193, June 1934)

II. PHOTOMETRY.

133. Measurements of Light by the aid of Enclosed Empty Spaces. H. J. Helwig.

Das Licht, 6, *pp.* 115-118, *June* 15, 1934.

The first instalment of a disstertation on the integrating sphere; the theory of light-measurement with this apparatus is discussed, with the aid of mathematical formulae. J. S. D.

134. Colour Measurement Technique. M. Richter.

Das Licht, 6, *pp.* 101-105, *June* 15, 1934.

In this instalment the author discusses methods of identifying and describing colours and classifies processes of measurement in three groups based on (a) direct comparison and judgment of similarity, (b) data relating to spectral composition, and (c) the use of measurements in three colours. These methods are discussed in turn, the use of the colour-triangle is illustrated, and various types of colorimeters are briefly described. J. S. D.

135. Determination of the transverse spacing with two-series distribution of light sources. E. R. Andersson.

Licht u. Lampe 23. *No.* 12, *p.* 291, *June* 7, 1934.

Presents a graphical method of solution of the above problem. E. S. B-S.

III. SOURCES OF LIGHT.

136. Coiled Coil Filament. Anon.

Elect. 112, *p.* 768, *June* 1, 1934.

Reference is made to a new filament construction for a 40-watt gasfilled lamp, as a result of which the luminous output is increased. C. A. W.

137. 115-volt Mercury-Vapour Lamp Proves Highly Efficient. A. V. Smith.

El. World, 103, *pp.* 724-727, *May* 19, 1934.

A description of a new 115-volt high pressure mercury-vapour lamp is given. Several diagrams and curves are included, illustrating the electrical characteristics of the lamp, whilst two photographs show the appearance of installations using these lamps. W. C. M. W.

IV. LIGHTING EQUIPMENT.

138. Combined Adaptor and Plug. Anon.

El. Times, 85, *p.* 735, *May* 31, 1934.

A brief description of a combined adaptor and plug, which dispenses with the two-piece apparatus usually employed. W. R. S.

139. Projector Arc Control. Anon.

El. Review, cxiv, *p.* 374, *March* 16, 1934.

Describes briefly apparatus for the remote control of projection arcs, enabling arc current to be increased at will from a convenient point in the theatre. The stage switchboard and rotating colour-screen batten arc also described. J. M. W.

V.—APPLICATIONS OF LIGHT.

140. Lighting in a Modern School. Anon.

El. Times, 85, *p.* 761, *June* 7, 1934.

Among other modern features, the equipment described includes a laylight having daylight glass in the art room of the school. A photograph is presented. W. R. S.

141. Up-to-Date Lighting in Modern Villa Construction. H. Ude.

Licht u. Lampe, 23, *No.* 11, *p.* 265, *May* 24, 1934.

Description and photographs of the lighting of a modern villa by night and by day. E. S. B-S.

142. Manchester Central Library. Anon.

El. Review, cxiv, *pp.* 443, 441, *March* 30, 1934.

Describes and illustrates the lighting in the new Manchester Central Library. J. M. W.

143. Notes on Wiring. "Megohm."

El. Times, 85, *p.* 793, *June* 14, 1934.

An examination of the value of 2-ampere wall sockets for lighting and other purposes. The use of both 2-pin and 3-pin plugs is considered, and also the lampholder adaptor. W. R. S.

144. New Methods in the Production of High Value Tungsten Bodies for Electric Incandescent Lamps and Other Purposes. B. Duschnitz.

Licht u. Lampe, 23, *No.* 12, *p.* 288, *June* 7, 1934.

The principle of the new methods consists in producing by heat and pressure a coherent body from coarse ductile pieces of tungsten. This body can be worked further by mechanical treatment, according to the use for which it is intended. E. S. B-S.

145. Industrial Lighting. H. C. Wheat.

El. Review, cxiv, *p.* 783, *June* 1, 1934.

A general discussion of the advantages and principles of good industrial lighting. J. M. W.

146. Patchy Lighting. C. W. Sully.

El. Review, cxiv, *p.* 822, *June* 8, 1934.

A plea for higher illumination and greater uniformity of illumination in street lighting. J. M. W.

147. Gaseous Lamps in Industry. Anon.

El. Times, 85, *p.* 597, *May* 3, 1934.

The use of high pressure mercury vapour discharge lamps for interior lighting is subject to certain difficulties which at present limit their sphere of usefulness. However, an installation of such lamps has recently been made in a foundry with, it is claimed, very satisfactory results. A photograph is given.

W. R. S.

148. Modern Lighting for the Shoe Industry. Anon.

El. Times, 85, *p.* 761, *June* 7, 1934.

A short account, with a photograph, of the lighting in the Sample Room of a shoe factory. Daylight has been excluded, and thus the whole lighting is artificial, and is said to be very effective. W. R. S.

149. The Romance of Highway Lighting. Anon.

El. Times 85, *p.* 793, *June* 14, 1934.

An interesting summary of street-lighting development, both utilitarian and decorative, from the early times until the present day, including a photograph of an arterial road lit with gaseous discharge lamps.

W. R. S.

150. Street Lighting by Gaseous Lamps. Anon.

El. Times, 85, *p.* 628, *May* 10, 1934.

A brief account, with photographs, of hot cathode mercury discharge lamps recently installed at Glasgow and Lewisham. W. R. S.

151. Hornsey Open-Air Bath. Anon.

El. Times, 85, *p.* 733, *May* 31, 1934.

A brief account, with a photograph, of a recent floodlighting installation. W. R. S.

152. Parade Lighting. "Distributor."

Elect., 112, *pp.* 708-709, *May* 25, 1934.

A discussion on Parade Lighting is given, together with a photograph and particulars of a recent installation in Edgware. C. A. M.

153. The Lighting Installations of the Paris-Versailles Highway. Maurice Choix.

R.G.E., 35, *pp.* 613-619, *May* 5, 1934.

A detailed description of the lighting arrangements employed for the highway between Paris and Versailles is given. Sodium vapour lamps of approximately 100-watt rating are used. W. C. M. W.

154. Festival Lighting at Liverpool. Anon.

El. Times, 85, *p.* 731, *May* 31, 1934.

An account, with photographs, of a special lighting display marking the opening of the I.M.E.A. Convention at Liverpool. Both tungsten, filament, and gaseous discharge tubes are employed in large numbers: the display is said to be very striking. Photographs are given. W. R. S.

155. Floodlighting at Liverpool. Anon.

El. Times, 85, *p.* 793, *June* 14, 1934.

A photograph and brief description of the floodlighting of the headquarters of the I.M.E.A. Convention. Gaseous discharge, mercury vapour lamps were employed in special projectors. W. R. S.

156. Celebration Illumination in South Africa. Anon.

El. Times, 85, *p.* 573, *May* 3, 1934.

An account of some of the illumination schemes employed to celebrate the visit of Prince George to South Africa. Colour and ordinary tungsten filament lamp floodlighting was employed, and considerable use was made of gaseous discharge lamps, both for highway lighting and floodlighting. Photographs are given. W. R. S.

157. Fountain Lighting. G. A. Hack.

El. World, 103, *pp.* 766-769, *May* 26, 1934.

This article describes the lighting of the fountains at the 1934 World's Fair at Chicago. Details of the lighting arrangements and circuits are given.

W. C. M. W.

158. Industrial Users' Tests Set New Lamp-Life Ratings. C. C. Wilcox.

El. World, 103, *pp.* 694-696, *May* 12, 1934.

Details are given of tests carried out by the Studebaker Corporation in order to obtain reliable life-test data for lamps manufactured by two different companies. W. C. M. W.

159. Three-Light Lamps Fit Varied Church Needs. J. J. Tynan.

El. World, 103, *p.* 755, *May* 26, 1934.

The auditorium of a church measuring 43 ft. x 27 ft., and 15 ft. high, is lighted by eight indirect fittings, using two-filament triple wattage lamps. With 150-watt filaments in use, the illumination obtained on the working plane is 4.2 foot-candles, with 200-watt filaments, 6.0 foot-candles, and with both filaments together, 10.5 foot-candles. W. C. M. W.

160. Ultraviolet Illumination of Aquarium. P. Korda and M. Besnard.

World Power, 21, *p.* 290, *June*, 1934.

Bulletin de la Société Français des Electriciens IV., *pp.* 461-472, *May*, 1934.

A short summary is given of recent investigations, detailed in the second reference given above, on the effect of ultraviolet radiation upon plant and animal life in aquariums. C. A. M.

161. Portable Sound Film Apparatus. Anon.

El. Review, cxiv, *p.* 708, *May* 18, 1934.

A short description of a 35-mm. portable sound-on-film cinematograph projector, employing an incandescent lamp with an internal mirror. Automatic safety devices are used, and the apparatus complies with fire regulations. J. M. W.

Recent Patents

(Abstracts of recent Patents on Illumination & Photometry.)

408970. Improvements in and connected with Electric Lampholders and Reflectors.

Riant, S. H., October 18, 1932.

This specification is concerned with a holder and reflector for tubular electric lamps. Terminal sockets are mounted at the ends of a longitudinal frame, to engage the terminals at the ends of the lamp, and the mirror, which partially embraces the lamp, is pressed against it by springs carried on the frame.

409235. Improvements in Electric Lamps.

The General Electric Company, Limited, December 21, 1932 (*Convention, Germany*).

This specification describes a combined gas discharge and incandescent electric lamp, in which the helical filament is doubly coiled near the leading-in wires, so that the doubly coiled portions serve as the electrodes of the arc discharge.

409271. Improvements in the Suspension of Electric or Gas-lamps in Inaccessible Positions.

Walter Slingsby and Company, Limited, Slingsby, W., and Slingsby, T. J. L., August 19, 1932, *January* 17, 1933 (*three Cognate Provisional Specifications*).

This case covers suspension devices in which the lamp or the like hangs from a hook, and in which a latch arrangement is provided, so that, when the lamp is raised into position, it engages with the hook, but if it is slightly raised again and lowered, the hook is moved horizontally out of the way, so that the lamp may be lowered.

409300. Improvements in or Relating to Optical Projection Apparatus.

Naylor, J. P., and Naylor, K. R., November 25, 1932.

This specification relates to apparatus for projecting an image of a time indicating device, and the main feature lies in the driving of the time indicating device by a synchronous motor.

409556. Improvements in Connection with Reversing Signalling and for Road Illuminating Lamps for Motor Vehicles.

Evans, C. J., August 1, 1932.

According to this specification, a rearwardly directed lamp is controlled by a switch actuated by movement of a reverse stop such as is normally associated with the gear lever of a motor car.

Specifications Nos. 409557 and 409558 of the same applicant relate to similar subject matter in connection with preselector type gear-boxes.

409711. Improvements in or Relating to Electric Lighting Systems.

The General Electric Company, Limited, Davis, B., and Ellis, G., August 4, 1932.

This specification describes a system for lighting of controlled intensity and various colours by electricity. Lamps or groups of lamps are sequentially connected with a generator by a switching arrangement, and the voltage of the generator is controlled by a regulator. The switching arrangement is such that the lamps are automatically and sequentially dimmed. The regulator and switching means may be driven by an electric motor.

409953. Improvements in or Relating to Electric Incandescent Lamps of Tubular Form.

Mayer, H., December 10, 1932 (*Convention, Germany*).

According to this specification, in order to avoid uneven illumination of frosted or opaline envelopes of tubular lamps, the filament is supported upon struts fixed to a zigzag wire passing through the tube, but not touching the wall, so that the filament lies outside the plane of the zigzag wire.

410142. Improvements in or Relating to Light-Sensitive Apparatus.

Electrical Musical Industries, Limited, and Tedham, W. H., November 11, 1932.

This specification relates to photo-electric cells having a secondary cathode which emits electrons when excited by electrons photo-electrically released from the primary cathode, and describes such a cell in which each of the primary and secondary cathodes is of curved or dished shape.

410216. Improvements in and Relating to Vehicle, Signal, and Like Outdoor Lamps.

Smith, E., November 23, 1932.

This specification relates to lamps for penetrating fog of the kind having an axially adjustable light source in a concave reflector, and within a surrounding drum, in front of which is a plano-convex lens and a flat translucent surface. According to the specification, several such lamp elements are mounted in a common casing, and have one common translucent surface. A spindle is mounted concentrically of the whole, and carries a wiper arm for wiping the translucent surface. The spindle is rotated by an electric motor housed at the rear end of the common casing.

410089. Improvements in Globes or Shades for Electric Lighting.

The General Electric Company, Ltd., and Jones, J. H., November 2, 1932.

This specification describes a globe or shade consisting of a glass envelope of spherical or equivalent shape made in one piece, but having an upper zone of clear or diffusing glass, a reflecting zone covering only the diverging part of the globe above its central horizontal plane and a lower part of diffusing glass. The diffusing portions may be produced by etching or coating with opal enamel. The reflecting zone may be silvered.

410581. Improvements Relating to Electric Cathode Glow Devices.

Siemens Electric Lamps and Supplies, Limited, Oakley, P. D., and Aldington, J. N., February 25, 1933.

This specification covers a glow discharge lamp for alternating current containing characters or representations in sequential formation on different bus bars, those on one bus bar acting as opposite electrodes to those on the other bus bar.

410569. Improvements in or Connected with Gas Flash Lighting Apparatus.

Thomas Glover and Company, Limited, Talbot, P., and Hoyle, D. G. February 6, 1933.

This specification relates to gas flash lighting apparatus of the kind employing a double tilting plate acting as a valve.

A Milestone in Illumination

Some further notes on the Lighting of the Century of Progress Exhibition in Chicago.

(We are indebted to l'Illuminazione Razionale for the illustrations and descriptive matter embodied in this note.)

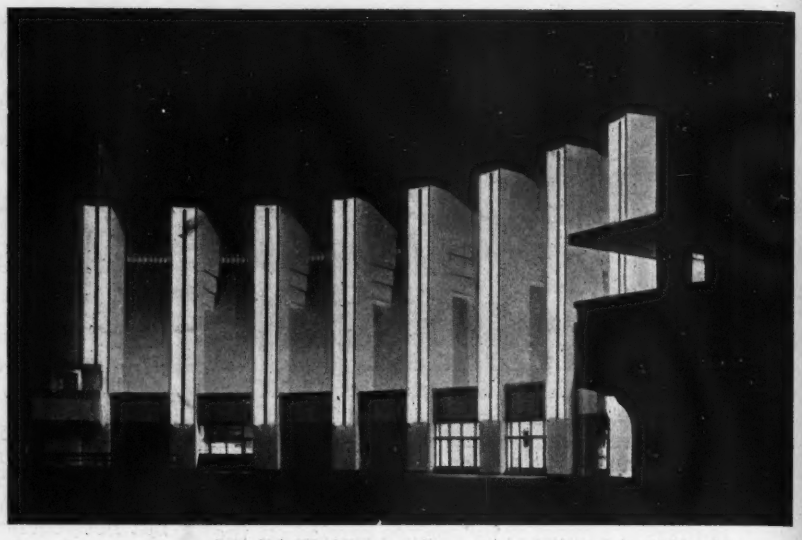


Figure 1. The Approach to the Palace of Science.

THE Century of Progress Exhibition, held in Chicago last year, may justly be described as a Milestone in Illumination. A summary of the thousands of individual light-sources, the mass of projectors varying in capacity from 500 to 3,000 watts, the arc lamps, and the thousands of feet of electric discharge tubes, would convey no idea of the impressive effect obtained by methods at once bold and simple.

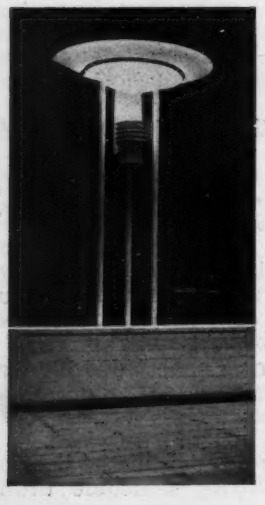
The accompanying illustrations, for which we are indebted to the courtesy of "l'Illuminazione Razionale," will serve to give an idea of some of these striking effects—which were described in Mr. Hibben's recent address to the Illuminating Engineering Society. They must, however, fail to represent the actual appearance, the absence of colour being naturally a great limitation.

Our first illustration (Fig. 1) shows the Palace of Science, the bold and attractive appearance of which fully justified the position at the extremity of the Avenue of "Flags of All Nations"—symbolising the absence of frontiers in true knowledge and the fraternity of all scientific workers. Semicircular in form, and sectionally divided by eight massive uprights separated by an inclined roof, it formed an excellent subject for flood lighting. Its surface, like that of many other buildings, was faintly colour-tinted, and it was illuminated by white light from concealed sources. Here, as elsewhere throughout the immense grounds of the exhibition, it was clearly demonstrated that it is not the luminaire, but the light it emits, that is mainly instrumental in creating an attractive and exhilarating effect—the light serving to make a structure of good design even more impressive by night than by day.

The Avenue of Flags. which, as mentioned above, led up to the Palace of Science at its extremity, carried during the day flags of all nations drooping from slanting poles. At night time the distinctive character of the avenue was maintained by two rows of poles, each 21 ft. high, and bearing, across the upper six feet of this length, eleven cross-bars, each composed of two 100-watt tubular open-surface incandescent lamps, each 36 in. long. Between each of the eleven cross-bars gigantic washers 20 in. in external diameter, and painted white, were situated.

The Bridge of the Planets (Fig. 2) was a most effective piece of work, not only on account of the originality of the lighting standards, which lined the bridge on each side, but because of the low diversity factor. The extensive overhead reflectors, semicircular in design, had an extreme radius of 4 ft., and were mounted 16 ft. above the parapet. The surfaces of the reflectors were given a light yellow finish. Each received the beam of light from a 500-watt projector, concealed in the lower ornamentation of the standard, about 30 in. away.

The Italia Palace (Fig. 3) was a typical example of impressive effects combined with simplicity of design. The free and unobstructed stairway fell partly under an illuminated canopy—receiving its light, like other sections of the exterior, from a



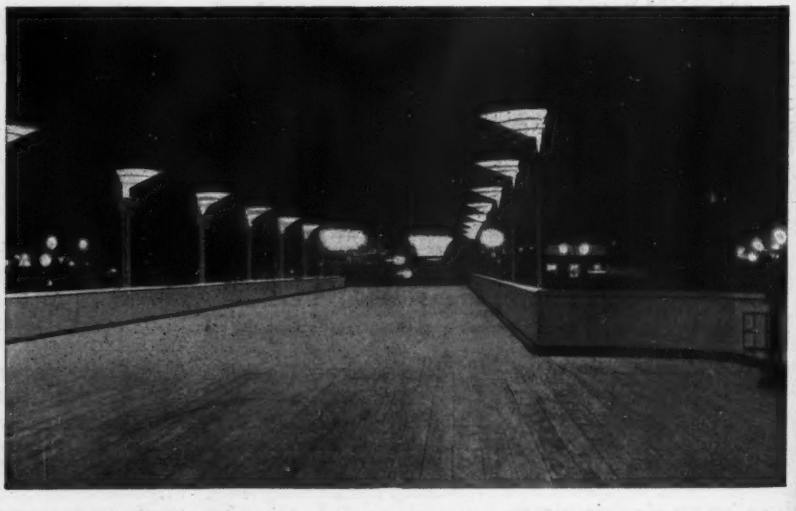


Figure 2. The Bridge of the Planets, with its original light standards (shown separately on left).

battery of 500-watt projectors, many of them concealed by the shrubby row of trees in the foreground. The building as a whole was well displayed, and its two important symbols clearly emphasised. These were the bundle of rods with an axe, the symbol of Fascism, and the canopy, symbolic of the successful flight over the Atlantic of the Italian "Armada." The Fascist symbol was centrally placed, with the rods lit by concealed vertical neon tubes; whilst the axe, the upper part, was of opaline glass, transmitting light from vertical rows of 15-watt lamps, spaced 12 in. apart.

Another striking building, the Palace of Agriculture, was surrounded by canvas-fronted columns about 20 ft. high containing a vertical line of 60-watt lamps backed by aluminium reflectors. The varnished canvas was painted white or yellow, and produced an effect resembling that of stained glass, whilst the transmitted light furnished powerful illumination, excellently diffused and free from glare, on the pathway and seats round the building.

A particularly striking effect was seen in the Chemistry Section, where, beneath a symbolic group of statuary depicting the alliance of theory and practice, a number of "pyrex" rods reached upwards. These curved rods, which were of large diameter, branched upwards and outwards. Beneath them were lamps with concentrated filaments, the light from which, by means of total internal reflection, penetrated throughout the material of the rods, which thus appeared as luminous bonds symbolising the interlinking of the various branches of chemical science.

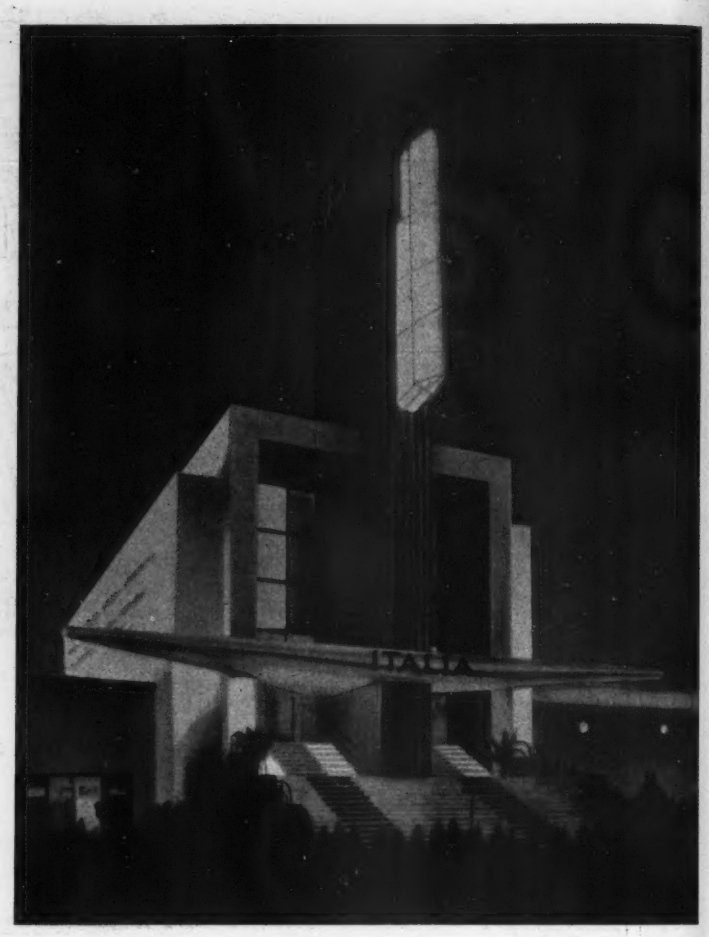


Figure 3. The Italia Palace, a simple and yet impressive display of architectural lighting.

Fatal Road Accidents for 1933

The M.O.T. Report on the above subject includes some useful new methods of classification. The tabular data in terms of "weather and light" are specially instructive. From them one can deduce the ratio of numbers of accidents occurring by night (darkness and semi darkness) to those occurring by day. The ratio thus deduced, approximately 55 per cent. for all conditions, is almost identical with that derived from the data of the National Safety First Association last year—surely a significant result when one recalls how much less is the traffic and how much fewer the pedestrians during most hours of darkness. For built up areas only the figure is slightly less and in non-built up areas only somewhat more (60 per cent.), an increase that might perhaps be ascribed to the fact that in such areas less artificial lighting is available. It is very instructive to observe, however, that if one considers accidents *involving pedestrians only* the ratio increases substantially, i.e., to 60 per cent. for built up to 80 per cent. for non-built up areas.

Still more striking is the result when this type of accident is studied during periods of rain or fog (instead of in all weathers). We find then ratios of 200 per cent. for built up areas and 400 per cent. for non-built up areas, i.e., in such circumstances the fatal accidents to pedestrians occurring in darkness or semi-darkness are respectively *twice* and *four times* those occurring during the day.

Three main inferences from these figures seem possible:—(1) the tendency to accidents is on the whole always greater by night than by day, which suggests that artificial lighting still falls short of safety demands; (2) the consequences of this inadequate lighting fall more heavily on pedestrians than drivers; and (3) during rainy and misty weather this handicap to the pedestrians is still further increased.

It would appear that during the "rush hours," 4-7 p.m., accidents are considerably fewer in mid-summer than in mid-winter, when artificial light has to be used, though the difference here does not seem so marked as in the case of the N.S.F. figures.

There are also classifications based on the nature of the street lighting (side and central, "good" and "poor"). It is disappointing to be unable to draw valid inferences from these. In general many more accidents are recorded in streets where the lighting was judged to be "good" than in those with "poor" lighting!—a singular result until one reflects that in all probability only a small proportion of roads (and those chiefly of a minor character, carrying little traffic) were judged to possess poor lighting.

The Lighting of the Home

As we go to Press we receive a copy of the latest Electric Illumination Handbook (No. 4B), issued by the E.L.M.A. Lighting Service Bureau, which shows, in a very agreeable manner, how the modern home should be lighted. Decorative as well as practical effects are illustrated. Each type of room is fully dealt with in succession. One is glad to see that, besides bedrooms, bathrooms, and living rooms, the garden and garage and such odd corners as the coal cellar are not overlooked.

The Illuminating Engineering Society

NOTICES

Programme for Coming Session.

The Programme for the next Session is now in course of preparation. We are asked to remind members that now is the time to send in to the Hon. Secretary offers of papers which would be eligible for premiums mentioned above. Papers recording original investigations and research would be specially welcome.

Revised List of Members.

The List of Members is now undergoing revision, and is about to be sent to Press.

If there are any other alterations in addresses which members still desire to have made, will they kindly send these in to the Hon. Secretary at once?

Subscriptions.

We have also been asked to remind members how much the work of the officers is lightened when subscriptions are promptly remitted. The termination of the financial half-year affords an opportunity of mentioning this point, which we are confident will receive prompt attention where necessary.

Royal Opera House, Covent Garden

In our description of the New Electrical Installation at the above in our last issue (p. 200) we omitted to state that the whole of the apparatus was manufactured at the Contractors' Works at Gunnersbury under the supervision of their Technical Director and Works Manager, Mr. M. Mansell, who, we understand, was responsible for the invention and design of the system of dimming adopted in the theatre.

Electric Discharge Lamps

Interesting Demonstration at Magnet House

The demonstration staged by the General Electric Co., Ltd., at Magnet House (London) on June 8, was extraordinarily interesting in showing the variety of electric discharge lamps now available and the manifold uses to which they may be put.

A selection of hot cathode discharge lamps was used to illustrate their development into the latest Osira lamp as used for street lighting, typical fittings for which were on view. This lamp, as is well known, has most interesting possibilities both for street and industrial lighting, the one limitation being the lack of an appreciable red component in the spectrum. This deficiency can, however, now be met to a great extent—though naturally at some sacrifice to efficiency. A new type of lamp, the spectrum of which is modified by the introduction of cadmium and zinc as an addition to mercury vapour, contains 2.8 per cent. of red radiation and operates at 30 lumens per watt (as compared with 40 lumens per watt yielded by the standard Osira lamp). A well-staged demonstration showed that this numerically small red component is most important in improving the appearance of coloured materials. Shades of red, if not revealed in the same way as when displayed under the light of incandescent "daylight" lamps, are at least recognisable, and a much nearer approach to natural colours is secured.

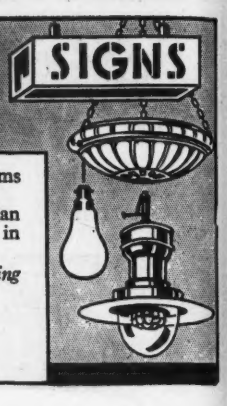
Other experiments were designed to show—what is perhaps as yet less familiar than the gain in efficiency of discharge lamps—the great advance in the production of coloured light which this form of source makes possible. A striking demonstration showed the superiority of 400-500 watt discharge lamps furnishing red light to 1,500 watt incandescent filament lamps equipped with red filters. Another form of lamp, only recently introduced, furnishes light of a deep blue colour. The former is highly effective when used to floodlight red brick buildings, the latter specially suited to the illumination of stone.

A most effective experiment showed the fundamental difference in colour—revealing qualities of a sodium lamp (fielding monochromatic light) and a yellow sprayed filament lamp. Visually the colour of the light furnished by the two lamps seemed almost identical, but the appearance of coloured objects, when exposed in turn to the two sources was utterly different—a warning to those too prone to rely on visual impressions! Other displays illustrated the possibilities of discharge lamps in producing coloured shadows and the difference in effect resulting from mixtures of the pure colours, which they yield, as compared with the impure colours yielded by incandescent lamps equipped with filters.

We reserve to the last what was, in some respects, one of the most interesting lamps on view—the compact Claudegen colour matching unit, which utilises tubing filled with carbon dioxide. Although such a gaseous discharge furnishes a line spectrum the lines are so well distributed that the resemblance to normal daylight is very close and the lamp is said to have proved admirable for colour-matching purposes.

These pictures illustrate the appearance at night of the Hornsey Public Baths, where there is accommodation for over 600 bathers, with sun-bathing terraces and promenade encircling the main pool, which is 165 ft. long and 75 ft. broad. Holophane 1,000 H.F. extensive type floodlights, equipped with 1,000 watt lamps and mounted 18 ft. high, illuminate the water. Special Holophane Lighting for the terraces, the ornamental gardens and fountain, and the dressing boxes is also provided.

·WHERE TO BUY·
A DIRECTORY OF LIGHTING EQUIPMENT



We invite applications for spaces in this new section of the journal. Particulars of terms for each space (approx. 1 inch deep and 3¼ inches wide) are given below.

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Seamless Steel Lighting Standards.
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Contracts Closed

THE BRITISH THOMSON HOUSTON, CO., LTD.

Royal Mail Lines, Ltd.—For part supply of Mazda lamps for twelve months ending July, 1935.

Glasgow Corporation Transport Dept.—For a substantial supply of Mazda lamps.

THE EDISON SWAN ELECTRIC CO., LTD.

Royal Mail Lines, Ltd.—For part of their requirements in electric lamps during twelve months from July 1, 1934.

THE GENERAL ELECTRIC CO., LTD.

Dundee Corporation Electricity Dept. — For twelve months' supplies of Osram metal filament, gas-filled and vacuum lamps, both pearl and clear types; also Robertson carbon filament lamps.

SIEMENS ELECTRIC LAMPS AND SUPPLIES, LTD.

The London County Council—For requirements of eletric lamps of all types during the ensuing twelve months.

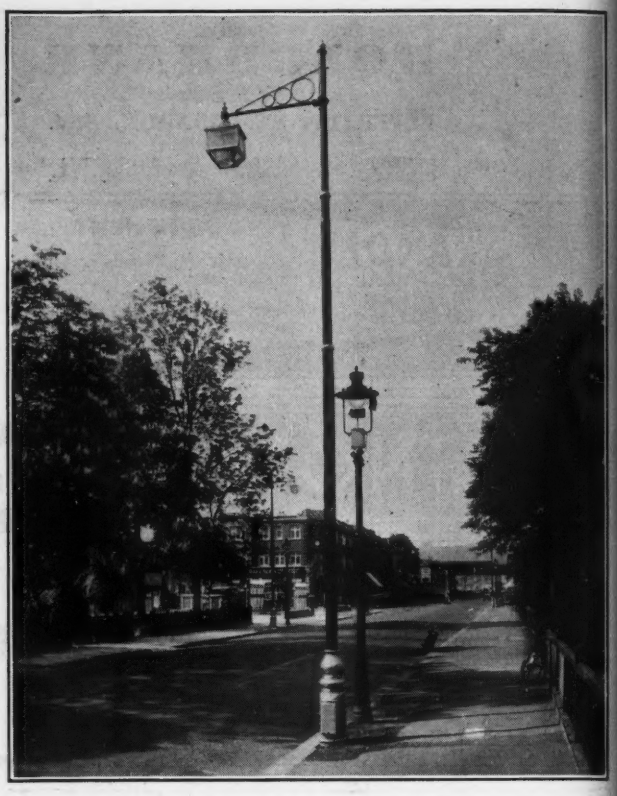
Newcastle-upon-Tyne Corporation — For the supply of Siemens Electric Lamps for six months.

Mazda Mercra Lighting at Coulsdon

One of the latest installations of electric discharge lamps—that of Mazda Mercra lamps in B.T.H. "Diron" lanterns, on a section of the Brighton-road, at Coulsdon, Surrey—is interesting for the fact that this is essentially a residential area. Residents have raised no objection to the colour—indeed, the effect on the foliage of trees in adjacent gardens is considered quite pleasing.

The installation consists of fourteen 400-watt units spaced approximately 143 feet apart and mounted at a height of 25 feet (which, as the accompanying illustration shows, represents a considerable increase as compared with the original system). The road width is 31 feet and the standards are staggered on alternate sides. The controlled distribution of light, effected by a combination of internal reflectors and prismatic outer glasses, enables the exceptionally good diversity factor of 4 to 1 to be attained on the roadway. The guaranteed mean test-point standard of 0.28 foot-candles has been exceeded.

The installation has been carried out by the County of London Electric Supply Co. to the general requirements of Mr. Gilbert A. Ballard, Engineer and Surveyor to the Coulsdon Urban District Council, the equipment being supplied by the British Thomson-Houston Co., Ltd.



New lighting at Coulsdon by Mazda Mercra Lamps in B.T.H. Diron Lanterns.

Electric Discharge Lamps in Glasgow

We learn that tests of electric discharge lamps are now in progress in Glasgow, under the supervision of the Public Lighting Engineer, Mr. S. B. Langlands, who has kindly sent us several photographs of the lighting, which we hope to use in our next issue.

Sodium Lighting in Morocco

A sodium lighting system has been installed by Philips on the 50-mile highway linking the two Moroccan ports of Casablanca and Rabat. At the inauguration ceremony Dr. A. F. Philips received from the dignitaries present congratulations on the success of the installation.

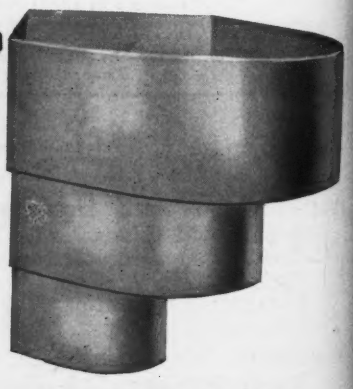
A Good Range of Reflectors

Those interested in efficient but inexpensive glassware and reflectors might with advantage pay a visit to Miss E. H. Dawson and Henckel in Gray's Inn-road (London), where an excellent assortment is always on view. Some of these have found very wide applications; in fact, we hardly like to say how many thousands of certain simple forms have been sold! On a recent visit we were struck by a type of reflector furnished with a special blue-tinted surface, giving a daylight effect. By this of course is understood a visual imitation of daylight—not an accurate light for colour-matching. This resemblance to daylight is, however, near enough to be quite useful and is very simply and efficiently obtained—the loss of light involved in the colouration being relatively small. We understand that such reflectors have proved specially acceptable for garden lighting.

Original Indirect Fittings

In the course of a recent visit to the premises in Regent-street we were shown some pleasing and novel types of "Monolamp" indirect lighting fittings, two types of which are illustrated below. We believe it is generally known that this firm specialise in indirect lighting, their well-known pedestal type of unit having proved a very popular one. In these, as in the two units illustrated below, much care is devoted to the distribution of light by the simple mirror-fittings housed in the designs. Skill is needed to avoid unsightly shadows and hard edges being cast by the rim of the unit. With the pedestal units these are completely avoided and even with wall brackets of the type shown below—which impose a harder test—the brightness shades off gradually and there is no hard line of demarcation.

A simple indirect bracket fitting.



Another novel and original design.

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